23rd Cambridge International Manufacturing Symposium
University of Cambridge, 26 – 27 September 2019

The Impact of the Fourth Industrial Revolution in the Ownership, Location and Internalization Advantages of Firms: An Exploratory Study

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Abstract

The Fourth Industrial Revolution, also called Industry 4.0 or I4.0, creates opportunities for improvement of efficiency and productivity, for the reshoring and redistribution of global manufacturing, and for the creation of new global value chains. As a consequence, Industry 4.0 has the potential to impact the internationalization strategy of global manufacturing firms. In order to analyze the transformations in supply chains enabled by the adoption of the advanced technologies of the Fourth Industrial Revolution, this research discusses how these technologies influence the ownership (O), location (L), and internalization (I) advantages of multinational companies (MNC). This study uses the advantages of the eclectic paradigm as constructs to understand how the internationalization strategies of multinational firms are impacted by the use of digitally-enabled technologies and processes described as the "Manufacturing Renaissance"

Keywords: Industry 4.0; OLI; Distributed Manufacturing; Reshoring, Internationalization

1. Introduction

The Fourth Industrial Revolution, also called Industry 4.0 or I4.0, creates opportunities for improvement of efficiency and productivity, for the reshoring and redistribution of global manufacturing, and the creation of new global value chains. As a consequence, Industry 4.0 has the potential to impact the internationalization strategy of global manufacturing firms. In order to analyze the impact of the adoption of Industry 4.0 technologies in the internationalization strategy of multinational companies, this research analyzes how the fourth industrial revolution impacts the ownership (O), location (L), and internalization (I) advantages of the eclectic paradigm. This study uses these OLI advantages as constructs in order to understand how the internationalization of multinational firms is impacted by the use of technologies of the fourth industrial revolution. Although the field research is in its early steps, results suggest that the adoption of I4.0 technologies do impact the OLI advantages. Initial reports show that I4.0 technologies change the Ownership advantages, reduces the Location advantages, and increases Internalization advantages of multinationals.

2. Literature Review

2.1 Industry 4.0

The technological advancements of the modern industries lead to a new phase of manufacturing, the era of the Fourth Industrial Revolution, or Industry 4.0. While the first industrial revolution was based on equipment and trade capitalism, the second in science, and the third in information and internationally networked capitalism (Alcácer, Cantwel & Piscitello, 2016), the fourth revolution is understood as a new industrial stage in which there is an integration between manufacturing operations system, and information and communication technologies (ICT) – forming the so-called Cyber-Physical Systems (CPS) (Dalenogare et al., 2018). In general, a cyber-physical system consists of three levels. The physical objects (e.g., production machines or warehousing systems), a virtual data representation of the mentioned physical objects in network infrastructure, and the services that are based on the available data concerning the physical objects (Drath & Horch, 2014). This fourth revolution "in its scale, scope, and complexity . . .will be unlike anything humankind has experienced before" (Schwab, 2016, "The Fourth Industrial Revolution," para. 1).

Due to the strategic importance of manufacturing and technology, several nations such as Germany, The United States, China, France, and Brazil created programs to disseminate the Industry 4.0 concepts and technologies in local firms (Dalenogare et al., 2018). Specifically, the European Union (EU) has developed policies to increase the adoption of emerging technologies and digitalization of production processes. Perhaps beginning in Germany, there is now an organized effort across member states to coordinate policies at the EU level to increase competitiveness and connect digital technologies with industrial products and services (Smit et al., 2016). Europe has the highest concentration of robots as manufacturing is seen as central to the economy and there are strong

efforts to attract talent and companies (DigitalEurope, 2018). After supporting the U.S. auto industry, the U.S. under the Obama Administration focused a policy effort to ensure a strong foundation for manufacturing growth and enabling the U.S. to be a leader in manufacturing competitiveness.

However, the real meaning of the term Industry 4.0 is debatable because this industrial revolution is still in its infancy due to the continuous emergence of and diffusion of new industrial technologies that allow products and devices to communicate with each other (Strange and Zucchella, 2017). As a consequence, there is little information available on how industry 4.0 will impact a firm's strategy (Agrawal, 2018). Moreover, studies of Industry 4.0 have been done mostly in computer science and are lacking in the fields of business and management (Chiarvesio and Romanello, 2019).

For Matthiae and Richter (2018, p. 2), I4.0 is characterized by "the combination of Internet technologies and future-oriented technologies in the field of smart objects (machines and products)" and "the convergence of industrial production and information and communication technologies". We report that the new digital technologies have considerable potential to disrupt how and where activities are located and organized within GVCs.

In order to present the complexity of the topic and the many technologies that can be part of the fourth industrial revolution, Chiarvesio and Romanello (2018) describe the nine pillars that sustain the current "Manufacturing Renaissance": (a) big data and analytics; (b) autonomous and collaborative robots; (c) simulation; (d) horizontal and vertical system integration; (e) the Industrial Internet of Things (IoT); (f) cybersecurity; (g) cloud; (h) additive manufacturing; and (i) augmented reality.

2.2 Industry 4.0, International Business and the OLI framework

There are some studies (Chiarvesio and Romanello, 2019; Gress and Kalafsky, 2015) that focus on the interface between internationalization and, global value chains and the Fourth Industrial Revolution. While these studies(references) cite that some of the technologies encapsulated under the umbrella of I4.0 impact the advantages described in the OLI framework, the literature review does not explain in which ways the technologies of Industry impact firm´s ownership, location and internalization advantages, and as a consequence the internationalization process of multinationals companies (MNC). Buckley and Strange (2015) propose that the location and internationalization strategies of multinational enterprises are changing with the implications for the global factory. According to the authors, technological advances have allowed the value chains to become more disaggregated in many different locations. Buckley and Ghauri (2004) suggest there is an improvement of a local firm through internalization of knowledge. Laplume et al. (2016) suggested a reconfiguration of global value chains because a wide adoption of 3D printing has the potential to partially reverse the trend toward fragmented, specialized, and globally dispersed supply chains. According to Rezk et al. (2016), computerized manufacturing technologies impact the geographic dispersion of manufacturing in two ways: first, such technologies fragment and disperse production; second, these technologies collapse and shorten multi-levels manufacturing chains. Strange and Zucchella (2017) studied the impacts in International Business (IB) of four groups of technologies: IoT, Big Data and Analytics, Robotics, and Additive Manufacturing. After explaining positive and negative implications related to the adoption of each technology, the authors discussed potential implications in terms of ownership (O), location (L), and internalization (I) advantages. With regards to ownership, for example, the authors argue that some technologies may change the logic behind the decisions of multinational enterprises about which activities of the value chain they should control. Regarding the location advantages, they have posed questions on how technologies that increase productivity may influence the geography of production. For instance, when applied in advanced countries, they could favor the relocation (or reshoring) of productive subsidiaries in developed economies. In light of the impacts of Industry 4.0, multinationals should increasingly internalize knowledge, while externalizing operations, in order to benefit from the internalization advantages. Therefore, industry 4.0 impacts the O, L, and I advantages of firms, a finding also shared by Chiarvesio and Romanello (2018), who reported that the new digital technologies have considerable potential to disrupt how and where activities are located and organized within Global Value Chains (GVCs), and who captures the value-added within those chains.

Alcácer et al. (2016) also point out the convergence of mutual influence between internationalization and the adoption of the technologies of the fourth industrial revolution. The authors indicate that the Internet of Things (IoT), one of the technologies of the new industrial revolution, changes the nature of competitive advantages of places (location advantages), the competitive advantages and strategies of firms (ownership advantages), and the governance structure of IB networks (internalization advantages, in a certain way). Piscitello (2016) and Cantwell and Piscitello (2015), in their analysis of location advantages in the information age, suggests that there is a parallel between the networks in which firms are embedded (which facilitate their O advantages) and the networks in which territorial areas are engaged (which enhance their L advantages).

"Once we allow for the centrality of the role of business networks in the explanation of both O advantages and L advantages, both kinds of advantages rely on the positioning of firms and locations in networked connections, which regulate their ability to make use of external capabilities. While certain basic kinds of L advantages may be

available to any firms located in a host site, for firms to be able to access more complex, socially embedded (and typically more valuable) types of L advantages requires some degree of insidership in the relevant business networks. Some of these networks may be strictly geographically local, as in the classical accounts of the benefits to local innovativeness of embeddedness in a geographic area, but others such as export business networks may reach beyond the location itself, especially to the extent that the relevant industry in the location itself is internationally open and connected (Alcácer et al., 2016, p. 508).

In the information age, O advantages incorporate as a central element capabilities to discover and integrate new combinations of knowledge taken from across diverse sources to create new value, and the primary O advantage of the MNC becomes its ability to innovate by developing new domains of application through such novel combinations; L advantages now focus more on the capacity of a location for interconnectedness with complementary locations elsewhere in the world (which capacity depends upon, but is not confined to location-bound systems), and so firm-location developmental interactions must be taken into account more fully (Piscitello, 2011); while I advantages can be adapted to incorporate the efficient overall coordination of GVCs that combine aspects of markets and hierarchies in the more flexible project-based networks, which are now orchestrated by flagship MNEs, and so allow for the spread of more open and informal but coherent inter-organizational (Piscitello, 2016).

Freeman and Louçã (2001) have pointed out that the information and communication technologies (ICT) age changed profoundly the character and the geographic distribution of IB activity. Thus, ICT tends to widen the geographic dispersion of international business networks, a conclusion later confirmed by Chen and Kamal (2016), who found that ICT adoption is positively associated with a greater likelihood of geographically dispersed in-house production, as measured by increases in intra-firm trade shares.

Specifically, with the location advantages, Grees and Kalasky (2015) stress that the geographies of production will change due to the technologies of additive manufacturing, which will reorganize manufacturing activities, thus impacting former L advantages of firms. Similarly, Rehnberg and Ponte (2018) exposed the progressive disintegration of production due to 3D printing (3DP) technology, which raises the discussion of how 3DP changes the location advantages. These authors also discuss, albeit briefly, that the adoption of 3DP is used to pre- and post-production activities in the aerospace industry, which correlates with the decrease of the number of first-tier suppliers and indirectly changes the I advantages. Table 1 presents a summary of the literature review of selected technologies of the fourth industrial revolution and their impact on the Ownership (O), Location (L), and Internalization (I) advantages of multinational companies. The O, L and I advantages will be used in the theoretical model that this paper analyses as well as in the hypothesis that will be tested.

Table 1. Summary of Literature Review.

Author (s)	I4.0 Technology	Impact on Ownership advantages for internationalization	Impact on Location advantages for internationalization	Impact on Internalization advantages for internationalization
Buckley and Strange (2015)	The article suggests Information and communication technologies are prerequisites of industry 4.0		International fragmentation of production	
Laplume et al. (2016)	3D Printing		Yes, potential to partially reverse the trend toward fragmented, specialized, and globally dispersed supply chains.	
Rezk et al. (2016)	computerized manufacturing technologies		Fragment and disperse production, and collapse and shorten multi-levels manufacturing chains	
Strange and Zucchella (2017)	IoT, Big Data and Analytics, Robotics, and Additive Manufacturing	Some technologies may change the logic behind the decisions of which activities of the value chain the multinational should control	Technologies that increase productivity may influence the geography of production, such as relocation (or reshoring) of subsidiaries to developed economies	Internalization of knowledge and eternalization of operations
Chiarvesio and Romanello (2019)	Big data and analytics, autonomous and	I4.0 may change the logic behind the decisions about	I4.0 poses questions on how technologies that increase productivity may	I4.0 technologies may internalize knowledge while

Author (s)	I4.0 Technology	Impact on Ownership advantages for internationalization	Impact on Location advantages for internationalization	Impact on Internalization advantages for internationalization
	collaborative robots, simulation, horizontal and vertical system integration, Industrial IoT, Cybersecurity, Cloud, Additive manufacturing, Augmented reality	which activities of the value chain they should control	influence the geography of production	externalize operations
Alcácer et al. (2016); Piscitello (2016),	IoT	Changes the nature of competitive advantages of places	Changes the competitive advantages and strategies of firms	Changes the governance structure of IB networks
Freeman and Louçã (2001); Chen and Kamal (2016)	Information and communication technologies		Information and communication technologies changed profoundly the character and the geographic distribution of IB activity	
Grees and Kalasky (2015)	Additive manufacturing		Geographies of production will change, which will reorganize manufacturing activities	
Rehnberg and Ponte (2018)	3D printing		Disintegration of production	

In conclusion, although the literature review of the Fourth Industrial Revolution and IB shows that I4.0 may impact OLI, there is a need for additional research to study in which ways the Fourth Industrial Revolution impacts the ownership, location and internalization advantages of firms and, as a consequence, will impact the internationalization strategy of firms. Therefore, this research will try to fill this gap in the literature.

3. Research Problem, theoretical model and hypotheses

The purpose of this study is to determine if the use of the technologies of the Fourth Industrial Revolution cause implications in global value chains, for MNCs in Brazil, Mexico, and the United States. These implications may be changes in the ownership, location and internalization advantages of multinational companies, such as, for instance, the reshoring of manufacturing activities (Kaltenecker, 2019). Therefore, the research question of the study is "What are the impacts of the adoption of the technologies of the Fourth Industry in the Ownership, Location and Internalization advantages of multinational firms, which will impact their international strategy?"

Assumption #1: The adoption of Industry 4.0 technologies reduces the *Ownership* advantages of firms

Assumption #2: The adoption of Industry 4.0 technologies reduces the *Location* advantages of firms

Assumption #3: The adoption of Industry 4.0 technologies reduces the *Internalization* advantages of firms

Figure 1 presents the visual representation of the theoretical model and the assumptions that will be tested

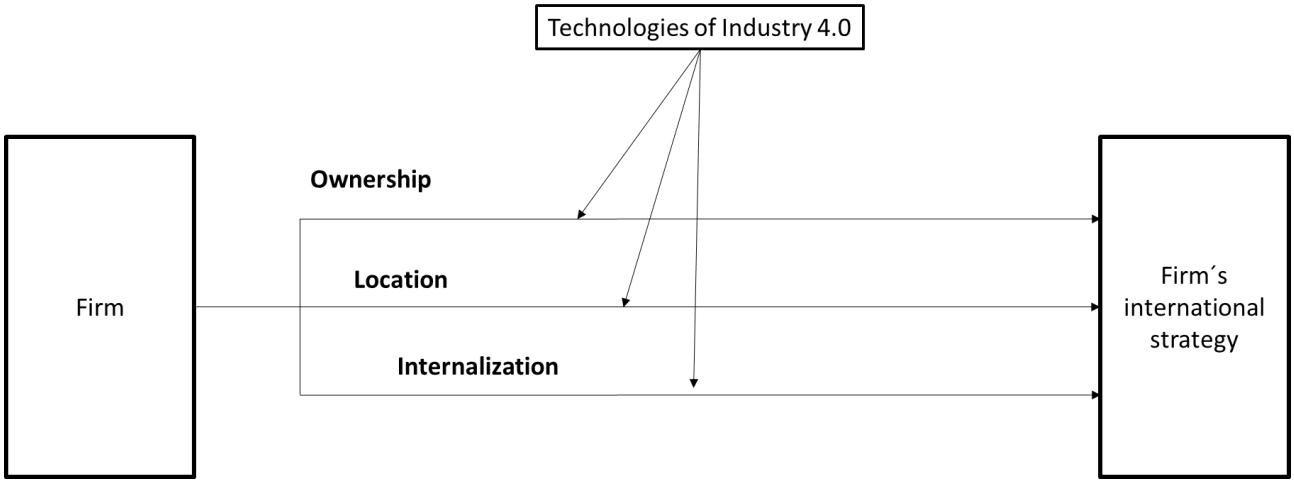

Figure 1. Theoretical model

4. Data Collection and Discussion

Since the analysis of the impact of the Industry 4.0 in international business is a topic that is both recent and understudied, the case study method is particularly suitable to the exploratory nature of the research question (Eisenhardt, 1989). A case study approach can help in learning more about an unknown or understood situation and generating preliminary support for a hypothesis (Leedy and Ormrod, 2005). Chiarvesio and Romanello (2019) used a similar methodology to investigate the propensity of companies toward emerging technologies attributable to "Industry 4.0" and their potential impact on firms' international configuration.

Preliminary results from the research show that big data, analytics, the Internet of Things (IoT) and artificial intelligence generate useful knowledge for the firms and changes their O and I advantages, which confirms evidence from non-academic literature (Crawford, 2018). However, a further collection of data is required to determine if I4.0 reduces or decreases O and I advantages. Additionally, the use of 3D Manufacturing seems to cause decentralization of manufacturing activities, a clear sign that it provokes changes in the Location advantages. As a consequence, although there is a need for more evidence to test the assumptions about the influence of I4.0 in the OLI advantages, initial data suggest that I4.0 changes the internationalization strategies of multinationals firms.

5. Conclusion

Although more data is required to finalize the conclusions of this research, the initial results suggest that the use Industry 4.0 tools change the international presence of multinationals because these technologies change the original balance of OLI advantages. While technologies such as 3D Printing may reduce Location advantages of firms, big data, analytics, the Internet of Things (IoT) and artificial intelligence change Ownership and Internalization advantages of firms.

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